REMARKS

Claims 1-15 remain in the application in amended form to more particularly define the invention and further distinguish the cited prior art. New claims 16 and 17 are added and depend from method claim 1 and apparatus claim 15, respectively.

Reconsideration is respectfully requested for claims 1-15, as amended, and consideration is requested for new claims 16 and 17.

The Examiner has objected to claim 14, and by the present amendment the objection noted by the Examiner has been addressed.

Claim 1 has been rejected under 35 U.S.C. 112, second paragraph, the Examiner questioning the limitation "measurement acquisition system" in lines 8 and 9.

By the present amendment the "measurement acquisition system" is added in the preamble of the claim and antecedent basis is now believed present.

Claims 1-15 have been rejected under 35 U.S.C. 102(b) as being anticipated by Paul et al. 5,230,102, the Examiner stating that Paul meets all limitations of the claims.

This rejection is respectfully traversed with respect to the claims as amended, which more particularly define the invention and further distinguish Paul and the other cited prior art. More particularly, independent claim 1 now specifies a method for analyzing tissue based on quantized magnetic resonance data using an MRI measurement acquisition system in which a magnetic resonance parameter is selected for characterizing tissue, and then a suitable pulse sequence is used to calculate and quantify the selected magnetic resonance parameter. Multiple sets of magnetic resonance signals are then acquired, and the magnetic resonance imaging parameters are calculated and quantified on a pixel-by-pixel basis for the multiple sets of magnetic resonance signals. Finally, biological properties of interest are determined by biological means including histological, biochemical, histochemical, and biomedical, and then the quantitative ranges

of the selected magnetic resonance parameters are correlated with selected biological properties of interest.

More particularly, claim 16 now specifies that calculating and quantifying the magnetic resonance imaging parameters on a pixel-by-pixel basis includes preparing a histogram plot of the frequency distribution of the parameter.

Additionally, dependent claims 4 and 5 specify creating a color image of the tissue based upon representation of sets of one or more quantitative magnetic resonance parameters.

Apparatus claim 11 specifies magnetic resonance apparatus for use in analyzing a body comprising means for establishing a magnetic field through the body, means for exciting nuclei spins in the body, and means for receiving magnetic resonance signals from the excited nuclei representative of nuclei spins. Further, the means for exciting and means for receiving cooperatively obtain a multiplicity of sets of magnetic resonance signals and calculate a magnetic resonance quality from the body. Means is then applied for quantifying the magnetic resonance quality pixel-by-pixel within the body.

Dependent claim 15 further specifies in the apparatus a display for color imaging the magnetic resonance qualities pixel by pixel, and dependent claim 17 specifies that the means for quantifying prepares a histogram plot of the frequency distribution of the parameter.

This is in accord with the summary of the invention given on page 2 of the specification that the invention is directed to using magnetic resonance parameters in the diagnosis of and prognosis for damaged tissue. In describing a specific embodiment, the summary of the invention states that known MRI data acquisition techniques are employed to collect signal data on a pixel-by-pixel basis for use in calculating MRI parameter values, and the range of values for each magnetic resonance parameter can be color coded to provide a spatial map of pixels to provide a spatial picture of the quality of tissue.

While Paul et al. describe a method for diagnosing cartilage based on magnetic resonance image, and while Paul does utilize signal intensity which is weighted by T1 dependence, Paul does not teach **calculating** T1 parameter values or other parameter values specifically. Note Col. 4, line 52 which refers to the degree of T1 weighted dependence of signal intensity, Col. 9, line 56 which refers to a T1 weighted vector and Col. 10, line 5 which refers to factors that influence signal intensity. Indeed, claim 1 of Paul et al. refers to quantifying a signal intensity of a magnetic resonance image, and claim 12 refers to comparing a peak signal intensity of the signal intensity pattern. Thus, Paul et al. are using relative signal intensities, rather than actually calculating and quantifying magnetic resonance imaging parameters as specifically defined in claims 1-15 and 16-17.

Further, claims 4, 5, 9, and 10 all refer to creating a color image of tissue based on the determined magnetic resonance qualities, and nowhere does Paul et al. suggest the use of color imaging in displaying the tissue parameters, such as histograms of the parameters.

Accordingly, it is submitted that the method for analyzing tissue as defined by claims 1-10 and 16 and the magnetic resonance apparatus as defined by claims 11-15 and 17 as now specifically defined, are neither shown nor suggested by Paul et al.

Claims 1, 2, 5-7, and 10-15 have been rejected under 35 U.S.C. 102(e) as being anticipated by Ackerman et al. 6,185,444, the Examiner again stating that Ackerman teaches each element of the claims.

This rejection is believed to be in error with regard to claims 1, 2, 5-7, and 10-15 as amended. As described above, the claimed invention is directed to analyzing tissue based on quantized magnetic resonance data in which multiple sets of magnetic resonance signals from tissue are acquired and then magnetic resonance imaging parameters are calculated and quantified on a pixel-by-pixel basis. Claim 16 further specifies that the quantifying of the magnetic resonance imaging parameters on a pixel-by-pixel basis includes preparing a histogram plot of the frequency distribution of the

parameter, and dependent claim 5 specifies creating a color image based on representation of sets of one or more of the quantitative magnetic resonance parameters.

While Ackerman et al. are concerned with calculating bone mineral density using magnetic resonance principles, Ackerman et al. utilize image intensity rather than actually calculating and quantifying the magnetic resonance quality from acquired magnetic resonance signals. Note for example in Col. 10, lines 54-57 where Ackerman et al. describe mean pixel intensity over an entire image can be computed and then the image intensity can be normalized on a pixel-by-pixel basis with respect to mean pixel intensity. Thus, Ackerman is utilizing parameter-dependent image intensities without actually calculating the parameters.

Further, Ackerman does not show or suggest creating a color image based on the representation of sets of one or more quantitative magnetic resonance parameters, as specified in claim 5, which can be based on a histogram plot of the frequency distribution of the parameter as specified in claim 16.

Method claim 1 and apparatus claim 11 have similar limitations in the obtaining and calculating of magnetic resonance qualities from a body and quantizing the magnetic resonance qualities pixel by pixel within the body.

Thus it is believed that Ackerman et al. neither show nor suggest the claimed method for analyzing tissue and the magnetic resonance apparatus for use in analyzing a body as defined by claims 1, 2, 5-7, and 10-15 as amended.

The prior art made of record but not relied upon has been reviewed and is believed to be distinguishable from the claimed invention as now defined. The papers of Dr. Tyler, Applicant herein, made of record in Applicant's Information Disclosure Statement, are directed to the use of quantitative magnetic resonance imaging for detecting and monitoring degeneration of osteoarthritic cartilage, but it will be noted in the 1995 Acta Thop Scand paper that T2 relaxation rates were estimated by fitting data from T2-weighted series of images on a pixel-by-pixel basis without actually calculating the parameter values.

Similarly, chapter 6 from Osteoarthritic Disorders refers to image contrast and the ability of MRI to distinguish between different tissues depending on the sensitivity of the MRI image intensity. See page 69. The use of magnetization relaxation curves, as shown in Figs. 3A and 3B, are referred to, and Drs. Tyler and Hall recognize the practical problem in producing sufficient experimental data to define relaxation curves such as those shown in Figs. 3A and 3B with sufficient precision that a computer program can then determine a corresponding MR parameter accurately. The description then goes on to refer to images that are fitted to a single time constant for each pixel element of an image and notes that it is important that it is only possible to compare MT values between different tissues providing they have identical T1 values, and in the conclusion it is noted that it is far more difficult to fully quantitate MR images in terms of the basic MR parameters such as T1, T2, MT, and diffusion coefficients.

Thus, these papers are similar to the cited Paul et al. and Ackerman et al. disclosures of using image intensities rather than calculated parameter values.

Wherli 5,270,651 does disclose a curve-fitting procedure for computing T2* for use in detecting osteoporosis. Again, mean signal amplitudes are computed and then a curve fitting procedure is utilized to find a value of T2*. Wherli recognizes that T2* is not directly related to bone density, but rather it is governed by geometry, thickness and density of trabecular plates.

Sharf et al. 6,144,199 is concerned with imaging a vessel wall anatomy where a tissue strained value is mapped into spatial dimensions; however, this appears to be unrelated to analyzing tissue based on quantized magnetic resonance data as defined by claims 1-15 as amended and dependent claims 16 and 17.

Since the claim objections have been addressed and claim 1 as amended is in compliance with 35 U.S.C. Section 112 paragraph 2, since claims 1-15 as amended and dependent claims 16 and 17 are patentable under 35 U.S.C. 102(b) and 103 over Paul et al., and since claims 1, 2, 5-7 and 10-15 as amended, along with claims 16 and 17 are patentable under 35 U.S.C. 102(e) and 103 over Ackerman et al., all as above set forth, it

is requested that claims 1-15 as amended, 16, and 17 be allowed and the case advanced to issue.

Should the Examiner have any question concerning the present amendment and response, a telephone call to the undersigned attorney is requested.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Sub B1 1. (Amended) A method for analyzing tissue based on quantized magnetic resonance data using an MRI measurement acquisition system comprising the steps of

a) selecting at least one magnetic resonance parameter to characterize a body part, organ or tissue,

A1 b) selecting a suitable pulse sequence to calculate and quantify that selected magnetic resonance parameter,

c) using the selected pulse sequence, acquiring **[to acquire]** multiple sets of magnetic resonance signals from the body part, organ or tissue at an unchanged position relative to the measurement acquisition system,

d) calculating and quantifying the magnetic resonance imaging parameters on a pixel by pixel basis,

e) determining biological properties of interest of a body part, organ or tissue structure by biological means including histological, biochemical, histochemical, and biomechanical, and

f) correlating quantitative ranges of the selected magnetic resonance parameters with selected biological properties of interest of a body party, organ or tissue.

Sub B1 4. (Amended) The method as defined by claim 3 and further including the step of:

A2 f) creating a color **[an]** image of the tissue based on representation of sets of one or more quantitative magnetic resonance parameters.

5. (Amended) The method as defined by claim 1 and further including the step of:

f) creating a color **[an]** image based on representation of sets of one or more quantitative magnetic resonance parameters.

6. (Amended) A method for analyzing tissue based on quantized magnetic resonance data comprising the steps of

a) acquiring magnetic resonance signals from the tissue,

b) determining at least one magnetic resonance quality of tissue in each pixel,

c) calculating and quantifying the magnetic resonance quality from **[quantizing]** the magnetic resonance signals pixel by pixel within the tissue, and

d) correlating the determined magnetic resonance quality with known magnetic resonance qualities of tissue.

9. (Amended) The method as defined by claim 8 and further including the step of:

d) creating a color **[an]** image of the tissue based on the determined magnetic resonance quality.

10. (Amended) The method as defined by claim 6 and further including the step of:

d) creating a color **[an]** image of the tissue based on the determined magnetic resonance quality.

11. (Amended) Magnetic resonance apparatus for use in analyzing a body comprising:

a) means for establishing a magnetic field through the body,

b) means for exciting nuclei spins in the body with an RF signal oriented at an angle with respect to said magnetic field,

c) means for receiving magnetic resonance signals from the excited nuclei representative of said nuclei spins,

d) means b) and c) cooperatively obtaining **[repeating steps b) and c) to obtain]** a multiplicity of sets of magnetic resonance signals and calculating **[determining]** a magnetic resonance quality from the body, and

e) means for quantifying **[quantizing]** the magnetic resonance quality pixel by pixel within the body.

13. (Amended) Apparatus as defined by claim 12 wherein means b) and means c) utilize **[steps b), c), and d) are]** pulse echo sequences with varying echo times.

14. (Amended) Apparatus as defined by claim 11 wherein the magnetic resonance quality is chosen from **[form]** T1 relaxation time, T2 relaxation time, and magnetic ratio.

15. (Amended) Apparatus as defined by claim 11 and further including

f) a display for color imaging the magnetic resonance qualities pixel by pixel.

16 (New) The method as defined by claim 1 wherein step d) includes preparing a histogram plot of the frequency distribution of the parameter.

17. (New) Apparatus as defined by claim 11 wherein means e) prepares a histogram plot of the frequency distribution of the parameter.